

CLAIMS

1. A device for use in a cardiovascular surgery on the beating heart comprising:
a means for stabilizing the beating heart comprising a contact member shaped to engage
the surface of the beating heart.
2. The device of claim 1 wherein said contact member is attached to a shaft means.
3. The device of claim 2 wherein said shaft means are affixed to a stable support.
4. The device of claim 1 wherein said means for stabilizing the beating heart are comprised
of two individual contact members having a greater overall thickness at their outer edges and
a passage therebetween.
5. The device of claim 1 wherein said contact members have a friction material on the
bottom surface.
6. The device of claim 5 wherein said friction material is comprised of a diamond plate, nail
bed, open pore foam, or textured material.
7. The device of claim 5 wherein said bottom surface is releasably affixed to said contact

members.

8. The device of claim 5 wherein said bottom surface is provided with a cushioning member having air or a fluid contained therein.

9. The device of claim 1 wherein said means for stabilizing the beating heart are a pair of substantially planar contact members.

10. The device of claim 9 wherein said substantially planar contact members are fixed in parallel orientation.

11. The device of claim 9 further comprising a counter contact member affixed to an interconnecting shaft is affixed to said contact members, wherein said counter-contact member and said contact members are at opposite ends of a said interconnecting shaft means affixed to said interconnecting shaft.

12. The device of claim 1 wherein said contact members have a hollow portion containing a conformable material therein.

13. The device of claim 12 wherein said conformable material is granular, a polymeric, or a gel.

14. The device of claim 13 wherein said contact member further comprises a plurality of disk elements disposed within said hollow portion of said contact member and a rigid member interconnecting said disk elements.

15. The device of claim 1 wherein said contact member has a plurality ports formed therein to receive the distal end of a shaft means.

16. The device of claim 15 wherein said plurality of ports are disposed about the periphery of the contact member and wherein said plurality of ports are releasably connected to a single shaft means.

17. The device of claim 15 further comprising a second shaft means having a distal end adapted to engage said ports on said contact members.

18. The device of claim 1 wherein said contact member is annular.

19. The device of claim 18 wherein said annular contact member has a fixture to receive a shaft means.

20. The device of claim 19 wherein said annular contact member has a passage formed through the bottom surface thereof.

21. The device of claim 1 further comprising means for introducing a positive or negative air pressure to said contact members.

22. The device of claim 21 wherein said means for introducing a positive or negative pressure to said contact members is comprised of a tube having a plurality of ports disposed therein.

23. The device of claim 21 wherein said contact member is further comprised of a manifold disposed within the body of said contact member and a plurality of ports in pneumatic connection with said manifold.

24. The device of claim 21 wherein said contact member has a slit in pneumatic connection with a positive or negative air pressure source.

25. The device of claim 21 wherein said tube has a malleable portion that is separable from said contact member and at least one port disposed in said malleable portion.

26. The device of claim 21 wherein at least one port communicates a positive pressure proximate to said contact members and a second port communicates a negative pressure proximate to said contact members.

27. The device of claim 21 wherein said positive or negative pressure is communicated by a single tube having a distal end with an opening proximate to said contact members and a proximal end operably associated with a shaft means.
28. The device of claim 1 further comprising a light source proximate to said contact members.
29. The device of claim 1 further comprising a surgical drape.
30. The device of claim 29 wherein said surgical drape is disposed about the periphery of said contact members.
31. The device of claim 30 further comprising structural support members affixed to said surgical drape.
32. The device of claim 29 wherein said surgical drape is affixed to a shaft means.
33. The device of claim 32 wherein said surgical drape has a retracted configuration wherein said drape is affixed to a shaft means.
34. The device of claim 29 further comprising extensions attached to said contact members

and having a drape attachment means.

35. The device of claim 1 further comprising a mechanism for attaching a source vessel to a target artery attached to said contact members.

36. The device of claim 35 further comprising a vessel receiving member affixed to said contact members.

37. The device of claim 36 further comprising a movable vessel support member.

38. The device of claim 37 wherein said movable vessel support member is mounted on a hinge and rotatable to align with said vessel receiving member.

39. The device of claim 2 further comprising a source vessel holder operably associated with said shaft means or said contact members.

40. The device of claim 39 wherein said vessel retention means is comprised of at least one clamp for gripping the distal end of a source vessel.

41. The device of claim 1 further comprising a cannula.

42. The device of claim 41 wherein said cannula is a component of a cannula assembly further comprising means for attaching said cannula assembly to the chest.

43. The device of claim 41 wherein said cannula has a threaded portion about the periphery thereof.

44. The device of claim 41 wherein said cannula is operably associated with a cannula locking mechanism having means for engaging adjacent ribs, and a locking mechanism to maintain said locking mechanism in engagement with adjacent ribs.

45. A means for stabilizing the beating heart comprised of a conical cannula having a distal end of a smaller diameter adapted to engage said beating heart at a bottom surface thereof and a proximal end having a larger diameter with an opening for introducing surgical instruments to the surface of the beating heart engaged by the distal end of said cannula.

46. The device of claim 1 wherein said contact members are formed of a malleable material.

47. The device of claim 1 wherein said contact member is retractable by rotation about a hinge connecting said contact members to a shaft means.

48. The device of claim 46 wherein said contact member formed of a material having a shape

memory.

49. The device of claim 47 wherein a pair of contact members are maintained in a retracted position in the interior of the hollow portion of a shaft means.

50. The device of claim 49 wherein said contact members are connected to a central shaft means by and wherein said central shaft is movable in relation to the hollow portion of said shaft means.

51. The device of claim 47 wherein a distal portion of each of two contact members are affixed to a the distal end of a shaft means, and a proximal portion of each contact member is affixed to the distal end of a guide means.

52. The device of claim 47 wherein said contact members are affixed to a plurality of struts at least two of which affix said contact member to said shaft means opposite said hinge.

53. The device of claim 1 wherein said contact member is formed of a single continuous wire.

54. The device of claim 52 wherein said single wire forms at least one loop.

55. The device of claim 1 wherein said contact member is formed of a helical coil.
56. The device of claim 54 wherein said helical coil is retractable into the body of a shaft means.
57. The device of claim 54 wherein said helical coil further comprises a spacing member disposed between the adjacent coils of said helical coil.
58. The device of claim 1 wherein said contact member is inflatable.
59. The device of claim 58 wherein said inflatable contact member forms a substantially annular cuff.
60. The device of claim 59 further comprising separate contact members disposed within the interior of said annular cuff.
61. The device of claim 58 wherein said inflatable contact member is retracted within the hollow portion of a shaft means when deflated.
62. The device of claim 1 when said contact members are formed of a unitary shaft having a split portion at the distal end thereof.

63. The device of claim 62 wherein said split portion is joined at a tip distal to said split portion.

64. The device of claim 2 wherein the length of said shaft means is adjusted by independent motion of an internal shaft and an external shaft.

65. The device of claim 64 wherein said shaft means has a ball joint at the distal end thereof for positioning said contact members.

66. The device of claim 65 wherein said ball joint is lockable by rotation of said inner shaft.

67. The device of claim 2 wherein said shaft means has an adjustable weight affixed thereto.

68. The device of claim 67 wherein said shaft means has a counter-weight at a proximal portion thereof, and a fulcrum attached to said shaft means at a point between said counter-weight and said adjustable weight.

69. The device of claim 2 wherein said contact members are attached to said shaft means by being integrally formed from a distal portion of a plurality of said shaft means wherein said distal portion of said shaft means is shaped to engage the beating heart.

70. The device of claim 69 wherein the distal ends of said plurality of shaft means are attached by an interconnecting member.

~~71.~~ The device of claim 2 wherein said shaft means has a positive or negative pressure source operably associated therewith.

72. The device of claim 2 wherein said shaft means has a light source operably associated therewith.

73. The device of claim 1 wherein said contact members are further comprised of a means for positioning epicardial tissue.

74. The device of claim 73 wherein said means for positioning epicardial tissue is comprised of sutures attached to said epicardial tissue and engaging said contact members.

75. The device of claim 74 wherein said sutures pass through openings in said contact members.

76. The device of claim 73 wherein said means for positioning epicardial tissue is comprised of open passages in said contact members.

77. The device of claim 76 wherein said means for positioning epicardial tissue is further comprised of a slidable member that engages epicardial tissue in said open passages.

78. The device of claim 73 wherein said means for positioning epicardial tissue is a functional clamp formed from crimping said contact member about said epicardial tissue.

79. The device of claim 1 wherein said contact members are rotatable circular rollers, wherein said rotatable circular rollers are also a means for positioning epicardial tissue.

80. The device of claim 1 wherein a contact members is further comprised of a frame, a spring mechanism, and a frame extension operably connected to said frame and said spring mechanism.

81. The device of claim 80 wherein said frame extension has a plurality of pins extending from the bottom surface thereof.

82. The device of claim 2 wherein a single shaft means is connected to a single contact member.

83. The device of claim 82 wherein a pair of said shaft means are interconnected by a pivot at an intermediate point.

84. The device of claim 82 wherein the said shaft means is adjustable along its length by continuous positioning of a first portion of said shaft means which engages a second portion and slides in relation thereto.

85. The device of claim 84 wherein said shaft means is further comprised of a spring mechanism disposed between said first and second portions of said shaft means.

86. The device of claim 1 wherein further comprising a plurality of pins extending from the bottom surface of said contact member.

87. The device of claim 86 wherein said plurality of pins engage a pair of contact members at a guide attached to each of said contact members.

88. The device of claim 1 wherein said contact member is comprised of the pair of plates having a deflected edge along one side thereof and a shaft means affixed to the opposite side.

89. The device of claim 88 further comprising a lever member positioned between the edge and the shaft means, and underneath said stabilizer plate in contact with said beating heart.

90. The device of claim 89 further comprising a suture for tilting said plate about said lever member when tension is exerted on said suture.

91. The device of claim 1 further comprising a lockable mechanism affixed to said contact members to depress epicardial tissue on either side of a target vessel, wherein said lockable mechanism is comprised of a block having a movable edge formed along one side and which rotates about a support member, wherein said lockable mechanism further comprises a hinge pin affixed to said block and said contact member.

92. The device of claim 91 wherein said lockable mechanism further comprises a locking member that fixes the position of said movable edge.

93. The device of claim 1 wherein said means for stabilizing the beating heart is comprised of a contact member having a shaft means with a distal portion adapted to fit within an arteriotomy in a target coronary artery.

94. The device of claim 93 wherein the distal portion of said shaft means is a substantially cylindrical lumen positioned substantially perpendicular to said shaft means.

95. The device of claim 91 wherein said substantially cylindrical lumen has cuffs at the edges thereof for engagement with the interior of the target artery.

96. The device of claim 1 wherein said contact member is substantially planar and has a substantially rigid surface with a centrally disposed opening for placement of a target artery.

97. The device of claim 96 further comprising an occluder extending beneath the surface of the rigid surface for engagement with the target coronary artery.

98. The device of claim 97 further comprising springed tissue retractors comprised of a coiled spring affixed to the planar surface of said contact member at one end at least one pin at the opposite end for engaging epicardial tissue.

99. The device of claim 1 further comprising an artery occluder comprised of a shaft with a blunt portion for engaging the target artery and wherein said shaft is affixed to a connecting shaft affixed to each of a pair of said contact members.

100. The device of claim 1 further comprising means for occluding said target coronary artery.

101. The device of claim 1 further comprising means for occluding a target coronary artery comprising a push bolt affixed to said contact member and wherein said push bolt is positioned downward to engage a target artery proximate to said contact member.

102. The device of claim 1 wherein said contact member is further comprised of means for occluding a target artery comprised of a roller having a portion positioned beneath said contact member.

103. The device of claim 1 wherein said contact member is further comprised means for occluding a target artery comprised of a movable clip affixed to said contact member, wherein said movable clip may be positioned to occlude a target coronary artery positioned proximate to said contact member.

104. The device of claim 2 comprising a pair of contact members and means for occluding a target artery comprised of a movable shaft within said shaft means, wherein the distal portion of said movable shaft engages a target artery disposed between said contact members.

105. The device of claim 100 wherein said means for occluding said target artery is comprised of a flange protruding from said contact member to permit a suture to be drawn about the flange.

106. The device of claim 105 further comprising a sliding shaft that is traversed by said suture.

107. The device of claim 105 further comprising a movable rod having a suture guide.

108. The device of claim 1 further comprising fixtures adapted to receive surgical instruments.

109. The device of claim 108 wherein said fixtures are magnetic.

110. The device of claim 2 wherein said shaft means have at least one flexible joint.

111. The device of claim 110 wherein said flexible joint is between said shaft means and a connecting shaft affixed to a pair of said contact members.

112. The device of claim 110 wherein said flexible joint is between said interconnecting shaft and said contact members.

113. The device of claim 110 further comprising a locking mechanism at each flexible joint.

114. The device of claim 2 wherein said shaft means is a flexible, lockable arm having a plurality of interconnecting links.

115. The device of claim 114 wherein said interconnecting links are comprised of a ball portion and a receiving portion wherein said ball portion fits conformably within said receiving portion and wherein a cable passes within said interconnecting links.

116. The device of claim 114 wherein said flexible, lockable arm is comprised of sphere joints and cylindrical tubes having a tensioning cable passing within said interconnecting links.

117. The device of claim 114 having an inflatable internal balloon passing within said

interconnecting links.

118. The device of claim 114 wherein said flexible, lockable arm is comprised of a plurality of curved segments interconnected by a tensioning cable wherein each of said curved segments has an interfacing surface having teeth adapted to engage the interfacing surface of an adjacent curved segment to prevent rotation therebetween.

119. The device of claim 118 further comprising bushings traversed by said tensioning cable and shaped to fit within a recessed portion of each of two of said interfacing surfaces.

120. The device of claim 2 wherein said shaft means is comprised of a flexible shaft having means for fixing the position of said flexible shaft.

121. The device of claim 119 wherein said means is comprised of a granular material that fixes the position of said flexible shaft rigid upon introduction of a negative pressure.

122. The device of claim 120 wherein said means is a plurality of interconnected disks in a substantially parallel relationship wherein the outer portion of said disks engages the inner surface of the flexible shaft and wherein said disks are interconnected by an internal tensioning cable.

123. The device of claim 120 wherein said means is a gel or polymer which becomes substantially rigid upon exposure to light, heat, or chemicals.

124. The device of claim 2 wherein said shaft means is comprised of a plurality of adjustable links having retaining rings positioned between said adjustable links, and an elastomeric hydraulic medium within said adjustable links.

125. The device of claim 124 further comprising means for exerting a compressing force of said elastomeric hydraulic medium.

126. The device of claim 125 wherein said means is a pushrod having a distal end engaging said elastomeric hydraulic medium.

127. The device of claim 120 wherein said flexible shaft is further comprised of a plurality of strands contained therein and wherein said means is a mechanism at the proximal end of said shaft means for compressing said strands.

128. The device of claim 119 wherein said flexible shaft is further comprised of fluid-filled lumens and wherein said means is a fixture for sealing said lumens.

129. The device of claim 2 further comprising a fine adjustment mechanism having a plurality

of threaded cables traversing ports at a proximal portion of a shaft means.

130. The device of claim 2 wherein said shaft means is affixed to a stable support comprised of an access platform.

131. The device of claim 130 wherein said shaft means traverses a ball joint affixed to said access platform.

132. The device of claim 2 wherein said shaft means is further comprised of a spring-loaded mechanism having a spring disposed about said shaft means wherein an end of said spring engages an inner shaft and an opposite end of said spring engages an outer shaft.

133. The device of claim 2 wherein said shaft means is further comprised of a fluid-dampening mechanism having a chamber with an internal plunger wherein said plunger has a piston with an annular seal engaging the internal portion of said chamber.

134. The device of claim 132 wherein said spring mechanism abuts an interconnecting shaft of said contact members at a distal end and abuts an outer shaft at the proximal portion thereof.

135. The device of claim 2 wherein said shaft means is comprised of an adjustable central shaft having a threaded portion, wherein rotation of a thumbscrew at a proximal portion of said

shaft means engages the threaded portion of said central shaft.

136. The device of claim 2 wherein said shaft means is comprised of an outer sleeve engaging a second shaft having a plurality of splines at the exterior, wherein said outer sleeve and second shaft surround a first internal shaft having a ball joint at the most distal end thereof for positioning of said contact members, wherein said first internal shaft further comprises threads to permit adjustment by a handle.

137. The device of claim 136 further comprising a circular clip abutting the distal portion of said outer sleeve and having inner ridges engaging said ball joint.

138. The device of claim 2 wherein said shaft means is comprised of a malleable shaft having passing through a fixture for attaching said malleable shaft to a retractor.

139. The device of claim 2 wherein said shaft means is comprised of a plurality of link members interconnected by a cable connected to each linked member a pivotable attachment point, and wherein each said linked members has a torsion spring connected to a hinge displaced at the pivotable attachment points between said link members.

140. The device of claim 2 wherein the position of said contact members are adjustable by a

plurality of positioning cables affixed to a ball joint at the distal end of said shaft means and a positioning handle at the proximal end of said shaft means.

141. The device of claim 140 wherein said positioning handle has a recessed portion in the bottom thereof adapted to receive a post extending from the proximal end of said shaft means
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142. The device of claim 141 wherein said shaft means is affixed to a stable support.

143. The device of claim 2 wherein said shaft means has a pair of curved stabilizing arms having a proximal and a distal portion engaging a ratcheting fixture affixed to a retractor blade.

144. The device of claim 143 wherein said stabilizing arms are comprised of a pair of curved shafts wherein the curved portion of said shafts are intermediate to said proximal and distal ends.

145. The device of claim 2 wherein said shaft means are comprised of a plurality of malleable shafts wherein one end of each of said plurality of malleable shafts is affixed to a stable support and an opposite end is affixed to a contact member.

146. The device of claim 145 wherein said proximal ends of at least two malleable shafts are attached to opposing retractor blades and the distal ends of said malleable shafts are attached to

a contact member.

147. The device of claim 2 further comprising an adjustable arm for affixing said shaft means to a stable support.

148. The device of claim 147 wherein said shaft means is comprised of a pair of parallel shafts which slide relative to an axle contained in a tightening mechanism having a lock for tightening said mechanism about the parallel shafts.

149. The device of claim 147 wherein said adjustable arm has an adjustable slide mechanism allowing said shaft means to move relative to said stable support, wherein said shaft means are affixed to a stable support by said adjustable arm and wherein said adjustable arm has a locking mechanism.

150. The device of claim 147 wherein said adjustable arm is comprised of a ball joint traversed by said shaft means, a tightening shaft for fixing the position of said ball joint, and a locking mechanism for fixing the position of the shaft means relative to said stable support.

151. The device of claim 2 wherein said shaft means is comprised of upper and lower dual shaft members wherein said upper dual shaft members are attached to said lower dual shaft members by an elbow joint wherein the attachment point of said upper and lower shaft members

is a hinge in the body of said elbow joint, and wherein said lower dual shaft members are affixed to said contact member.

152. The device of claim 2 wherein said shaft means is comprised of a plurality of individual shaft members connected by horizontal rotating joints wherein a proximal portion of said shaft means is affixed to a retractor blade and a distal portion is affixed to a vertical shaft.

153. The device of claim 2 wherein said shaft means are affixed to a retractor for adjustable positioning of said shaft means relative to a retractor blade.

154. The device of claim 153 wherein said shaft means is comprised of a lower shaft concentrically oriented within an upper shaft and locking means for fixing the position of the lower shaft relative to the upper shaft, wherein a proximal portion of said upper shaft is affixed to a retractor blade.

155. The device of claim 153 wherein a plurality of adjustable shafts have a distal end affixed to a contact member and a proximal end affixed to a retractor blade.

156. The device of claim 153 wherein said shaft means is comprised of a lockable, rotatable arm having a first hinge for rotation of said arm relative to said retractor blade and a second hinge for vertical positioning of said rotatable arm relative to said retractor blade.

157. The device of claim 153 wherein said shaft means has an adjusting knob affixed to a proximal end and a telescoping shaft member extendable from said retractor blade and having a contact member affixed to the distal end thereof.

158. The device of claim 153 wherein said shaft means is comprised of a flexible central shaft having a handle at one end, wherein said flexible shaft traverses a series of shaft guides wherein and wherein the distal portion of said flexible central shaft is affixed to said contact member.

159. The device of claim 158 wherein the most proximal shaft guide is affixed to the cross-member of a retractor.

160. The device of claim 158 wherein said shaft guides have a predetermined curve to fix the position of said central shaft.

161. The device of claim 2 wherein said shaft means traverses the body of a retractor and is held in place by an upper plate and a lower plate wherein said upper and lower plate engage a sphere traversed by said shaft means.

162. The device of claim 2 wherein said shaft means is comprised of a curved shaft extending from a cross-arm of a retractor, wherein said curved shaft extends from said cross-arm and has a length sufficient to extend below the position of said retractor blades, and wherein the distal

portion of said shaft has substantially horizontal shaft attached to said contact member.

163. The device of claim 2 wherein said shaft means is affixed to a rib locking mechanism, wherein said rib locking mechanism provides a stable support for said shaft means, and wherein said rib locking mechanism is comprised of adjustable posts engaging opposite sides of a rib proximate to a surgical incision.

164. The device of claim 163 wherein said rib locking mechanism is comprised of a post that is slidably engaged within a slot formed in said rib locking mechanism and that is positioned by a locking latch.

165. The device of claim 2 wherein said shaft means is comprised of a hollow unitary shaft wherein the bottom surface of said unitary shaft engages the beating heart.

166. The device of claim 165 wherein said hollow shaft has a lower cylindrical portion that splits into semi-cylindrical portions.

167. The device of claim 165 further comprising a plurality of openings in the body of the hollow shaft.

168. The device of claim 165 wherein a pair of said contact members are formed from the

body of said hollow shaft and are rotatable away from said body by a hinge.

169. The device of claim 165 wherein said hollow shaft has an annular ring formed in the bottom portion of said hollow shaft, and wherein said annular ring rotates about a movable rod to abut a target artery.

170. The device of claim 169 wherein said annular ring has at least one passage formed in said annular ring for positioning of a target coronary artery therein.

171. The device of claim 1 wherein said means for stabilizing the beating heart is comprised of an elongated sheath member.

172. The device of claim 171 wherein said elongated sheath member has a plurality of support attachments that are air or fluid-filled.

173. The device of claim 172 wherein said support attachments have a lumen for providing air or fluid.

174. The device of claim 171 wherein said elongated sheet is affixed to a crank at either end.

175. A means for positioning the beating heart comprising a substantially flat, flexible sheet,

having one side coated with a hydrogel-like material for adherence to an epicardial surface.

176. The device of claim 175 wherein said sheet is a two-sided structure having an interstitial space therebetween for perfusion of a fluid.

177. The device of claim 2 wherein said shaft means is comprised of a plurality of telescoping shafts having a distal end affixed to a contact member and a proximal end affixed to hydraulic actuator.

178. The device of claim 177 wherein each of said hydraulic actuators is attached to a retractor blade and is affixed to a hydraulic hose for remote actuation by a hand-activated switch.

179. The device of claim 2 wherein said shaft means is comprised of a plurality of arms connected by friction joints.

180. The device of claim 179 wherein said friction joints are comprised of an upper and lower housing surrounding a ball joint wherein one of said upper and lower housing has a friction surface disposed therein and the opposite housing has a friction engaging means positioned to engage the friction surface.

181. The device of claim 179 further comprising a rotatable shaft means having a central rod located within a housing and tongue forming a ratchet mechanism to fix the position of the rotatable shaft means.

182. The device of claim 181 wherein said rotatable shaft means are affixed to contact members by a hinge.

183. The device of claim 179 further comprising a locking mechanism attaching said shaft means to a retractor blade, wherein said locking mechanism is released by an internal cam shaft actuated by a handle.

184. The device of claim 2 wherein said shaft means is comprised of a flexible slide having a contractible shaft at the distal end thereof wherein said contractible shaft is attached to a contact member, and wherein said flexible slide is shaped to be inserted into a clip attached to a retractor blade.

185. The device of claim 184 further comprising hydraulic tubing containing fluid to extend said contractible shaft.

186. The device of claims 1, 2, 3, 29, 35, 39, 41, 93, or 153 wherein said means for stabilizing the beating heart is disposable and contained in a sterilized package.

187. The device of claim 175 wherein said means for positioning the beating heart is disposable and contained in a sterilized package.

188. The device of claims 1, 2, 3, 29, 35, 39, 41, 93, or 153 wherein said means for stabilizing the beating heart is sterilized and completely enclosed within a container that prevents contamination by microorganisms.

189. The device of claim 175 wherein said means for positioning the beating heart is sterilized and completely enclosed within a container that prevents contamination by microorganisms.